FIG.1

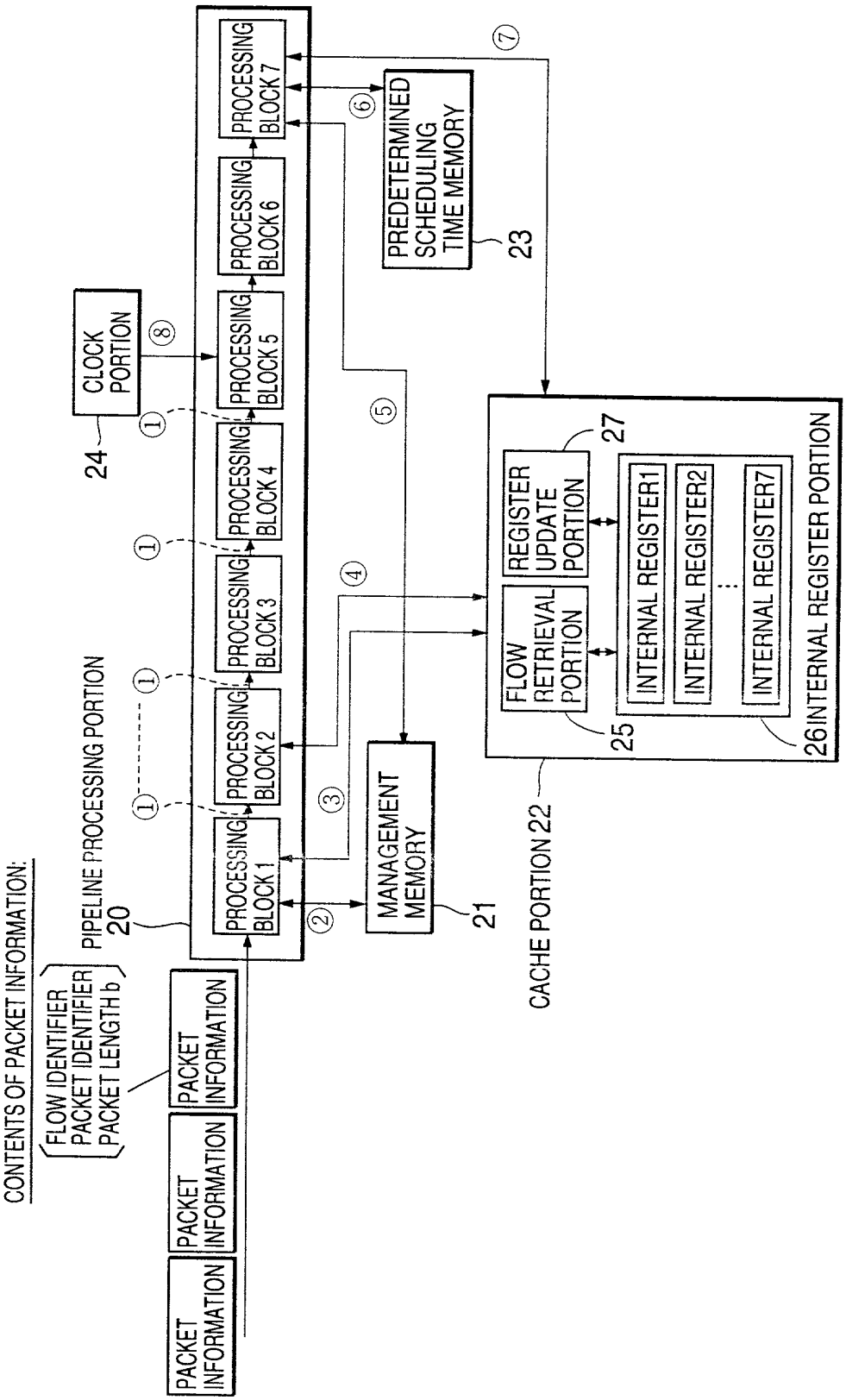

CONTENTS OF PACKET INFORMATION:
FLOW IDENTIFIER
PACKET IDENTIFIER
PACKET LENGTH b
PACKET INFORMATION
PACKET INFORMATION
PACKET INFORMATION
PIPELINE PROCESSING PORTION
20
PROCESSING BLOCK 1
PROCESSING BLOCK 2
PROCESSING BLOCK 3
PROCESSING BLOCK 4
PROCESSING BLOCK 5
PROCESSING BLOCK 6
PROCESSING BLOCK 7
CLOCK PORTION
24
MANAGEMENT MEMORY
21
PREDETERMINED SCHEDULING TIME MEMORY
23
CACHE PORTION 22
FLOW RETRIEVAL PORTION
REGISTER UPDATE PORTION
27
INTERNAL REGISTER1
INTERNAL REGISTER2
INTERNAL REGISTER7
25
26 INTERNAL REGISTER PORTION
①
②
③
④
⑤
⑥
⑦
⑧

FIG.2

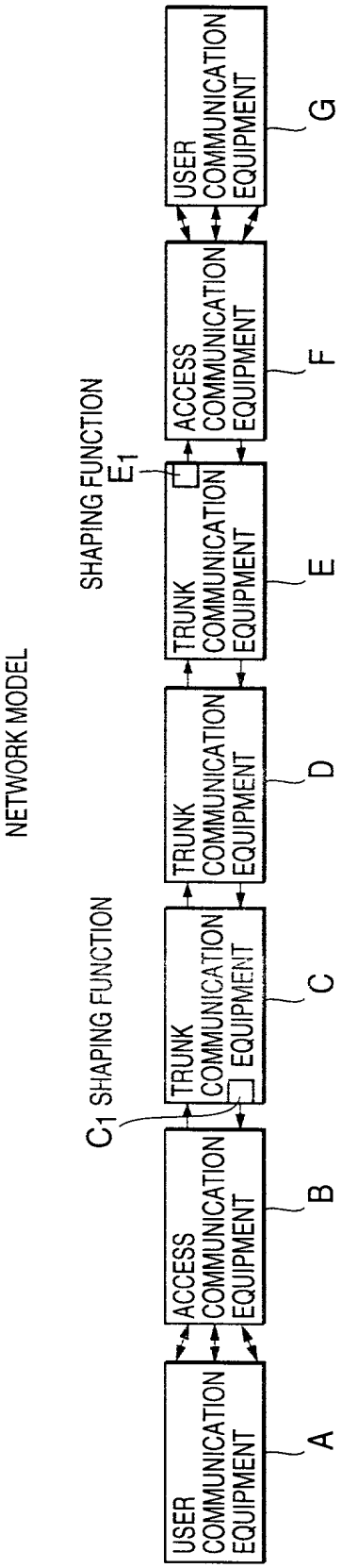

NETWORK MODEL
USER COMMUNICATION EQUIPMENT
A
ACCESS COMMUNICATION EQUIPMENT
B
TRUNK COMMUNICATION EQUIPMENT
C
TRUNK COMMUNICATION EQUIPMENT
D
TRUNK COMMUNICATION EQUIPMENT
E
ACCESS COMMUNICATION EQUIPMENT
F
USER COMMUNICATION EQUIPMENT
G
C1 SHAPING FUNCTION
E1 SHAPING FUNCTION

FIG.3

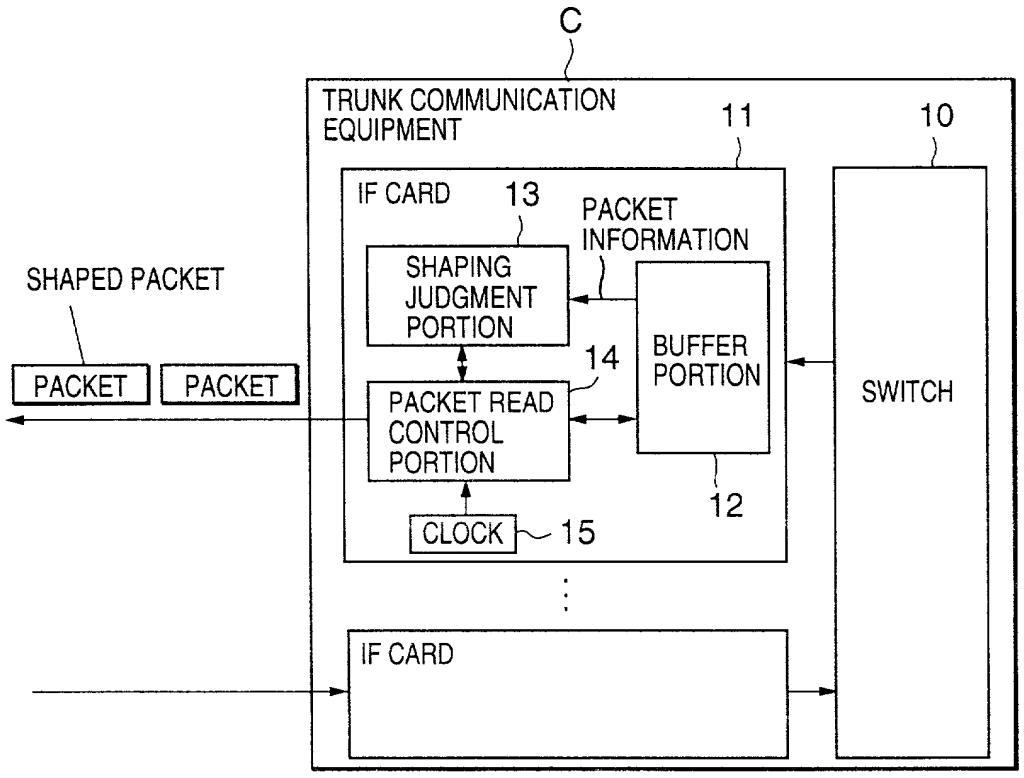

C
TRUNK COMMUNICATION EQUIPMENT
11
10
IF CARD
13
PACKET INFORMATION
SHAPING JUDGMENT PORTION
BUFFER PORTION
SHAPED PACKET
PACKET
PACKET
14
PACKET READ CONTROL PORTION
SWITCH
12
CLOCK
15
IF CARD

FIG.4

CONTENTS OF SIGNALS BETWEEN BLOCKS :

① SIGNALS BETWEEN PROCESSING BLOCKS IN PIPELINE PROCESSING PORTION
FLOW IDENTIFIER, PACKER IDENTIFIER, TK, L, P,PT; fbit, X, Y, Z, W, f2bit, Y2 AS INTERNAL CONVERSION

② FLOW IDENTIFIER AS MANAGEMENT MEMORY ADDRESS ; TK, L, P, RT AS DATA

③ PROCESSING BLOCK 1 → FLOW IDENTIFIER IN CACHE PORTION , CACHE PORTION → K, B IN PROCESSING BLOCK 1

④ PROCESSING BLOCK 2 → FLOW IDENTIFIER, PACKET LENGTH b IN CACHE PORTION

⑤ FLOW IDENTIFIER AS MANAGEMENT MEMORY ADDRESS, TOKEN ADDED VALUE TK,
TOKEN ADDITION INTERVAL L AS DATA, P = W AS NEW TOKEN VALUE, AND RT = Z AS NEW PREDETERMINED SCHEDULING TIME

⑥ PREDETERMINED SCHEDULING TIME Z, PACKET IDENTIFIER

⑦ PROCESSING BLOCK 7 → FLOW IDENTIFIER, PACKET LENGTH b IN CACHE PORTION

⑧ CURRENT TIME NT

FIG.5(A)

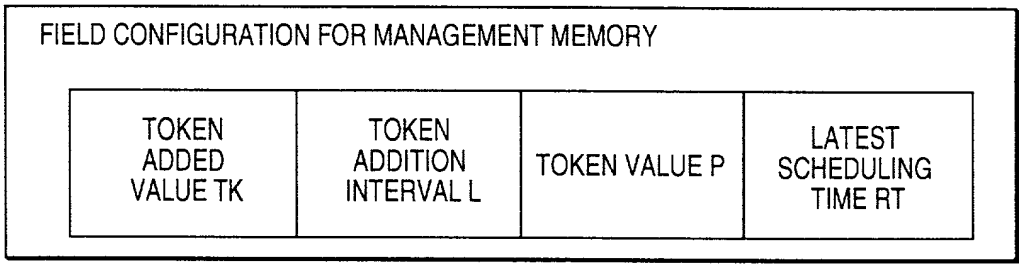


FIG.5(B)

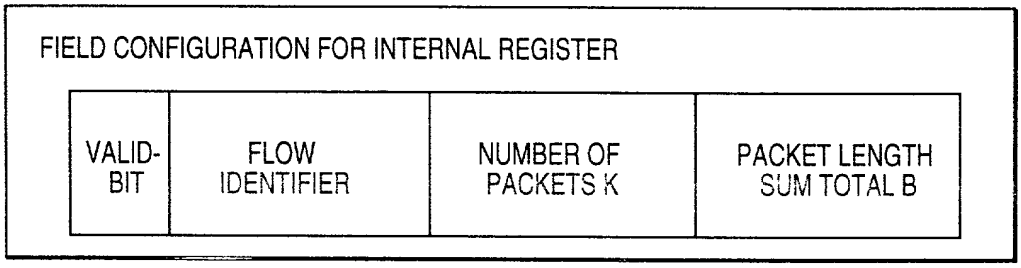


FIG.5(C)

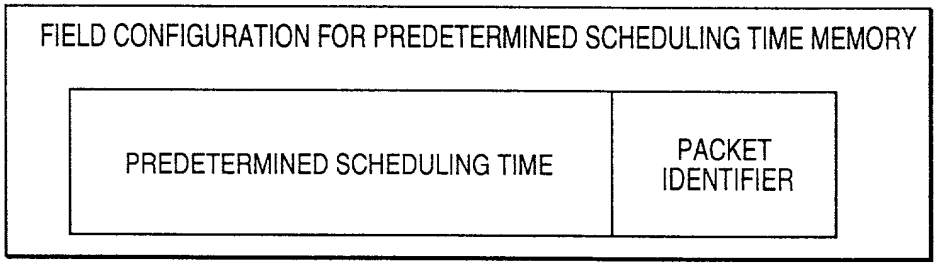


FIG.6

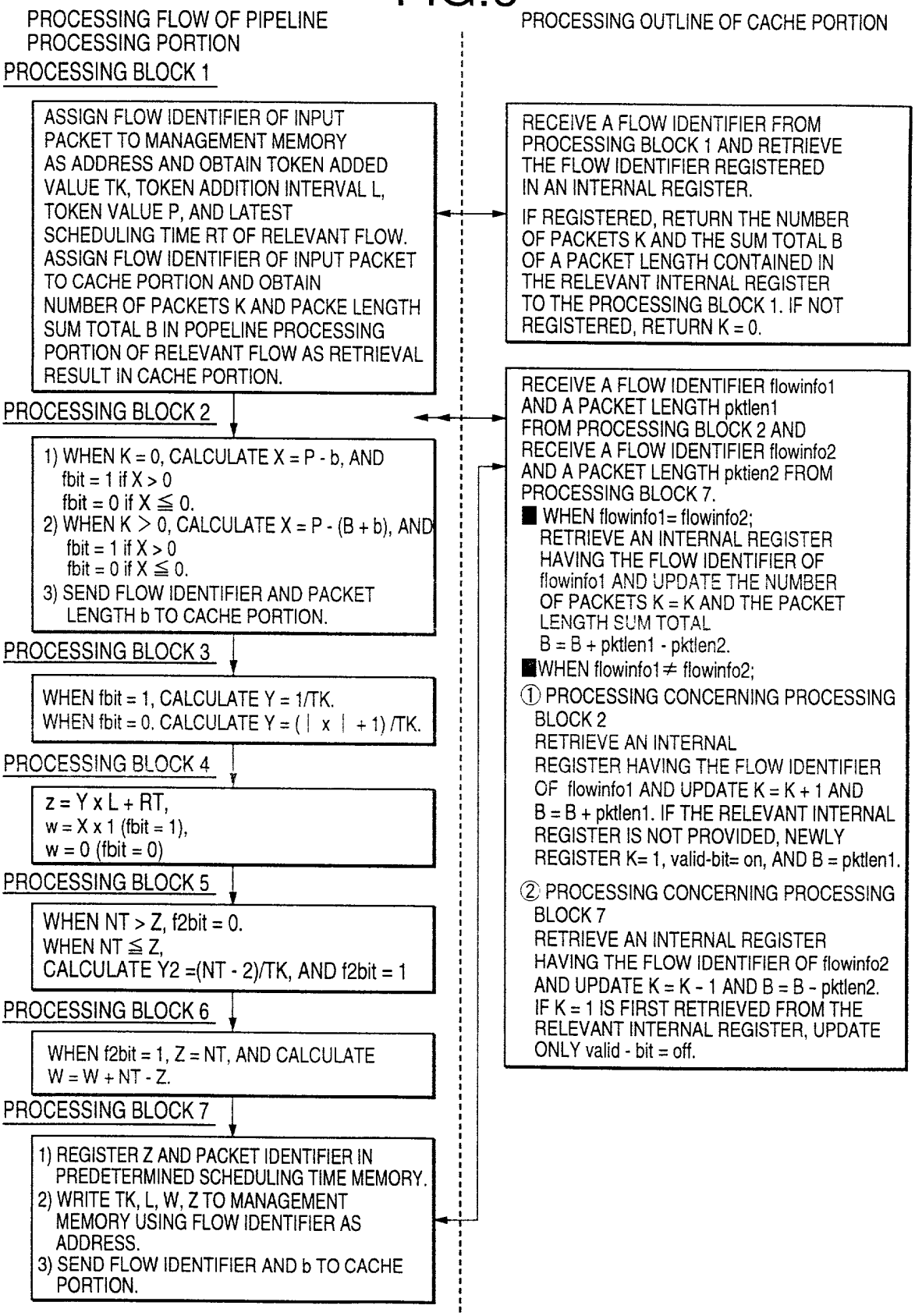

PROCESSING FLOW OF PIPELINE PROCESSING PORTION
PROCESSING OUTLINE OF CACHE PORTION
PROCESSING BLOCK 1
ASSIGN FLOW IDENTIFIER OF INPUT PACKET TO MANAGEMENT MEMORY AS ADDRESS AND OBTAIN TOKEN ADDED VALUE TK, TOKEN ADDITION INTERVAL L, TOKEN VALUE P, AND LATEST SCHEDULING TIME RT OF RELEVANT FLOW. ASSIGN FLOW IDENTIFIER OF INPUT PACKET TO CACHE PORTION AND OBTAIN NUMBER OF PACKETS K AND PACKE LENGTH SUM TOTAL B IN POPELINE PROCESSING PORTION OF RELEVANT FLOW AS RETRIEVAL RESULT IN CACHE PORTION.
RECEIVE A FLOW IDENTIFIER FROM PROCESSING BLOCK 1 AND RETRIEVE THE FLOW IDENTIFIER REGISTERED IN AN INTERNAL REGISTER.
IF REGISTERED, RETURN THE NUMBER OF PACKETS K AND THE SUM TOTAL B OF A PACKET LENGTH CONTAINED IN THE RELEVANT INTERNAL REGISTER TO THE PROCESSING BLOCK 1. IF NOT REGISTERED, RETURN K = 0.
PROCESSING BLOCK 2
1) WHEN K = 0, CALCULATE X = P - b, AND
fbit = 1 if X > 0
fbit = 0 if X ≦ 0.
2) WHEN K > 0, CALCULATE X = P - (B + b), AND
fbit = 1 if X > 0
fbit = 0 if X ≦ 0.
3) SEND FLOW IDENTIFIER AND PACKET LENGTH b TO CACHE PORTION.
RECEIVE A FLOW IDENTIFIER flowinfo1 AND A PACKET LENGTH pktlen1 FROM PROCESSING BLOCK 2 AND RECEIVE A FLOW IDENTIFIER flowinfo2 AND A PACKET LENGTH pktien2 FROM PROCESSING BLOCK 7.
WHEN flowinfo1= flowinfo2;
RETRIEVE AN INTERNAL REGISTER HAVING THE FLOW IDENTIFIER OF flowinfo1 AND UPDATE THE NUMBER OF PACKETS K = K AND THE PACKET LENGTH SUM TOTAL
B = B + pktlen1 - pktlen2.
WHEN flowinfo1≠ flowinfo2;
① PROCESSING CONCERNING PROCESSING BLOCK 2
RETRIEVE AN INTERNAL REGISTER HAVING THE FLOW IDENTIFIER OF flowinfo1 AND UPDATE K = K + 1 AND B = B + pktlen1. IF THE RELEVANT INTERNAL REGISTER IS NOT PROVIDED, NEWLY REGISTER K= 1, valid-bit= on, AND B = pktlen1.
② PROCESSING CONCERNING PROCESSING BLOCK 7
RETRIEVE AN INTERNAL REGISTER HAVING THE FLOW IDENTIFIER OF flowinfo2 AND UPDATE K = K - 1 AND B = B - pktlen2. IF K = 1 IS FIRST RETRIEVED FROM THE RELEVANT INTERNAL REGISTER, UPDATE ONLY valid - bit = off.
PROCESSING BLOCK 3
WHEN fbit = 1, CALCULATE Y = 1/TK.
WHEN fbit = 0. CALCULATE Y = (| x | + 1) /TK.
PROCESSING BLOCK 4
z = Y x L + RT,
w = X x 1 (fbit = 1),
w = 0 (fbit = 0)
PROCESSING BLOCK 5
WHEN NT > Z, f2bit = 0.
WHEN NT ≦ Z,
CALCULATE Y2 =(NT - 2)/TK, AND f2bit = 1
PROCESSING BLOCK 6
WHEN f2bit = 1, Z = NT, AND CALCULATE W = W + NT - Z.
PROCESSING BLOCK 7
1) REGISTER Z AND PACKET IDENTIFIER IN PREDETERMINED SCHEDULING TIME MEMORY.
2) WRITE TK, L, W, Z TO MANAGEMENT MEMORY USING FLOW IDENTIFIER AS ADDRESS.
3) SEND FLOW IDENTIFIER AND b TO CACHE PORTION.

FIG.7

EXPLANATION OF VARIABLES :

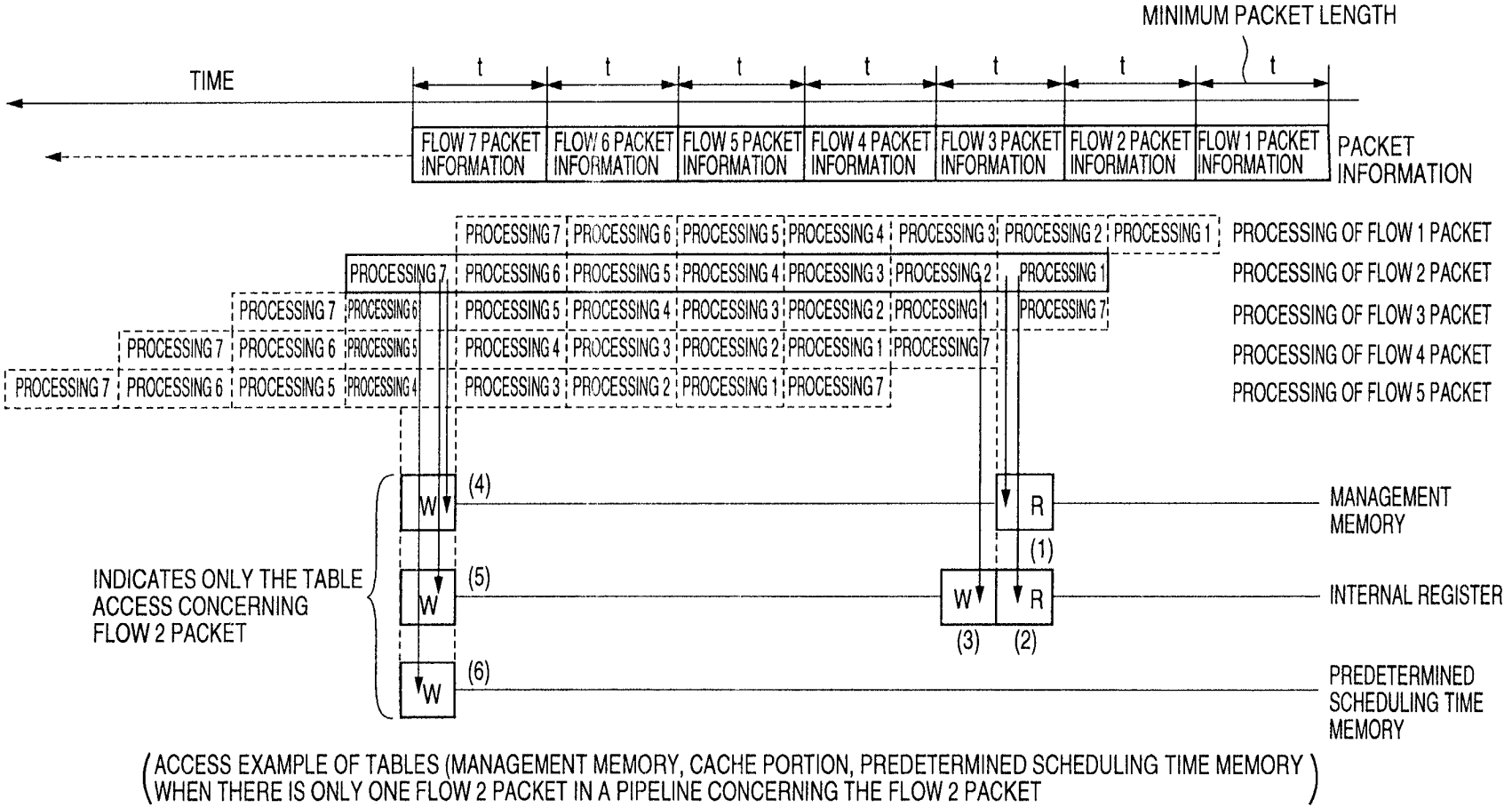
① READ FROM MANAGEMENT MEMORY
TK = TOKEN ADDED VALUE
L = TOKEN ADDITION INTERVAL
P = TOKEN VALUE
RT = LATEST SCHEDULING TIME

② READ FROM CACHE PORTION
K = NUMBER OF PACKETS
B = PACKET LENGTH SUM TOTAL
valid-bit = REGISTER ENABLED AND DISABLED

③ INTERNAL VARIABLES
fbit = IDENTIFICATION AS TO WHETHER TOKEN IS SUFFICIENT
X = INSUFFICIENT TOKEN AMOUNT
Y = NUMBER OF NECESSARY TOKEN ADDITION INTERVALS
Z = NEWLY PREDETERMINED SCHEDULING TIME
W = NEW TOKEN VALUE
f2bit = NEWLY PREDETERMINED SCHEDULING TIME
INDICATES CROSS REFERENCE BETWEEN Z AND CURRENT TIME.
Y2 = Z AND NUMBER OF TOKEN ADDITION ITEMS ADDED UNTIL CURRENT TIME

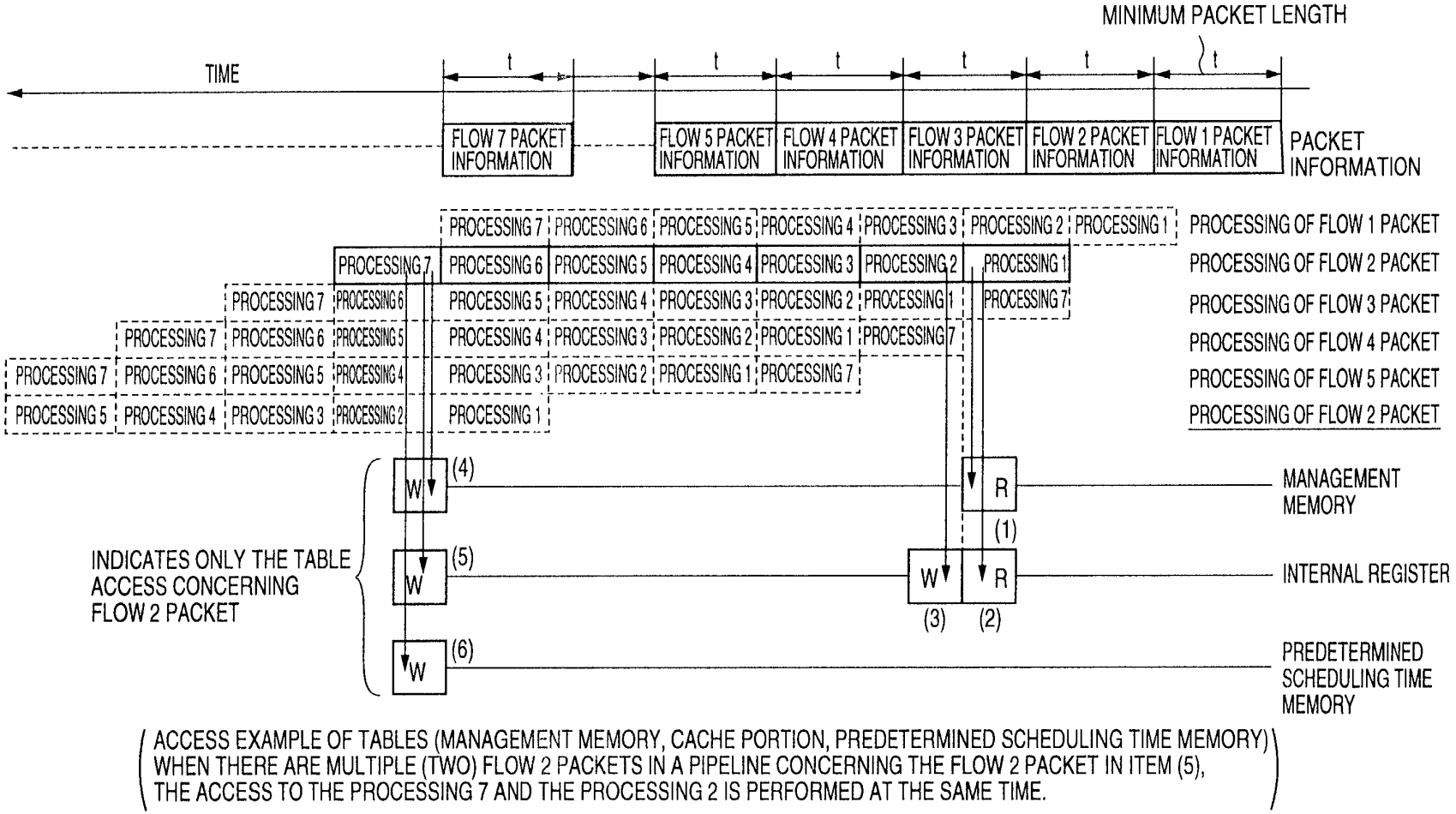
④ OTHERS
b = PACKET LENGTH OF PROCESSING PACKET
NT = CURRENT TIME

FIG.8



(ACCESS EXAMPLE OF TABLES (MANAGEMENT MEMORY, CACHE PORTION, PREDETERMINED SCHEDULING TIME MEMORY WHEN THERE IS ONLY ONE FLOW 2 PACKET IN A PIPELINE CONCERNING THE FLOW 2 PACKET)

FIG.9



ACCESS EXAMPLE OF TABLES (MANAGEMENT MEMORY, CACHE PORTION, PREDETERMINED SCHEDULING TIME MEMORY) WHEN THERE ARE MULTIPLE (TWO) FLOW 2 PACKETS IN A PIPELINE CONCERNING THE FLOW 2 PACKET IN ITEM (5), THE ACCESS TO THE PROCESSING 7 AND THE PROCESSING 2 IS PERFORMED AT THE SAME TIME.

FIG.10

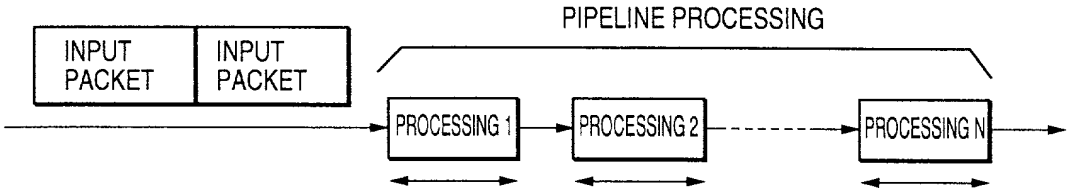
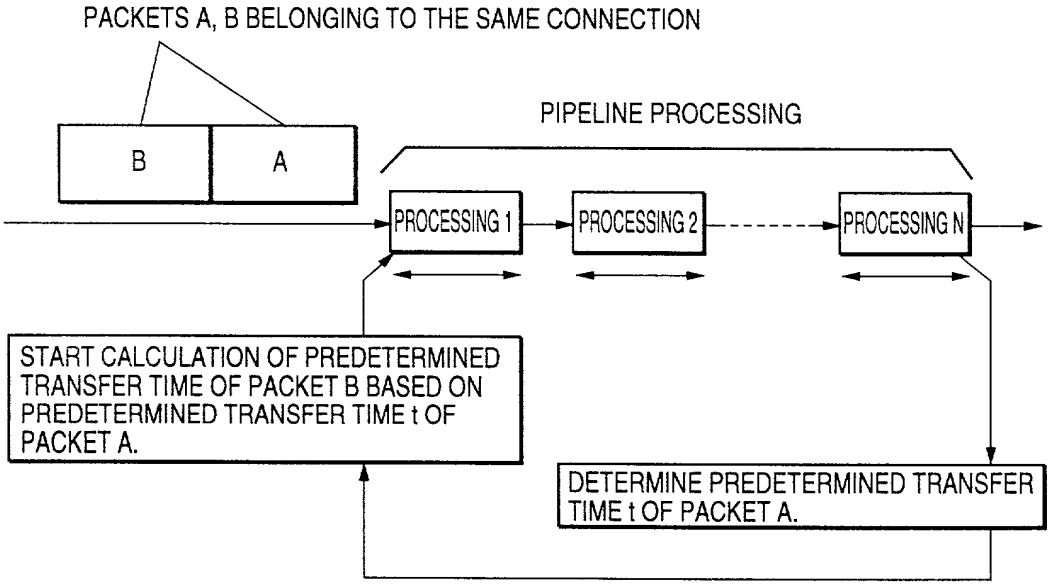

PIPELINE PROCESSING
INPUT PACKET
INPUT PACKET
PROCESSING 1
PROCESSING 2
PROCESSING N

FIG.11


PACKETS A, B BELONGING TO THE SAME CONNECTION
PIPELINE PROCESSING
B
A
PROCESSING 1
PROCESSING 2
PROCESSING N
START CALCULATION OF PREDETERMINED TRANSFER TIME OF PACKET B BASED ON PREDETERMINED TRANSFER TIME t OF PACKET A.
DETERMINE PREDETERMINED TRANSFER TIME t OF PACKET A.